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Improving Supply Chain Sustainability:
A Purchasing Model Based On a Company Pioneering Sustainability
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Improving Supply Chain Sustainability: A Purchasing Model Based On A Company Pioneering Sustainability

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Summary:
This thesis studies the improvement in sustainability practices related to the indirect footprint of a company by providing a purchasing model and recommendations to decrease it. It also incorporates the use of a Factor or Matrix of unique Factors (named Differentiating Factor) calculated using qualitative and quantitative data to achieve precision on the prioritization of this data.

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KEY INSIGHTS

1. Indirect CO_2 emissions could represent a high percentage of the total emissions produced by the companies.
2. Efficient as well as easy to use tools will begin the real structural change among all kinds of industries
3. A prioritization tool, straightforward to build and capable of capturing as much information as needed, can simplify the structure of some analytical models.
4. With basic public information, it is possible to start decreasing the indirect footprint by choosing suppliers that are either more "environmentally friendly" or closer.

Introduction

One of the most important topics in today's business world is corporate social responsibility. An important part of corporate social responsibility is environmental sustainability. Despite the fact that every company has a different vision regarding sustainability, this issue will become the main driver of the world operations within the next 10 years, depending on how fast the environment is depleted. Easy-to-apply approaches can be the first tools to use as an immediate start for the companies with no sustainability research at all. Companies that are already ahead in sustainability will be the ones with the higher competitive advantages.

One of the major issues in environmental sustainability is climate change, which is a very critical problem due to possible short and long-term consequences. Studies show that increases in greenhouse gas emissions could lead to catastrophic consequences in the long term, including but not limited to global warming ("Back to Basics", 2008; UNFCCC, 2011). Some of these effects in nature such as the unusual changes in weather conditions have started to occur.

If a company contributes in a significant way to climate change, it will suffer criticism from the stakeholders as well as society. This fact could directly affect its profitability. Although reduction and disclosure of emissions in supply chains have been achieved for some companies, value chain (or indirect) emissions are mostly ignored or unaccounted for due to two important facts: 1) Difficulty in directly influencing them, and 2) difficulty in calculating or even estimating them.

When the necessity of tracking or accounting for the indirect footprint arises, the following questions need to be answered by any particular company: How significant is the amount of raw materials purchased every year? What is the percentage each raw material accounts for? Is there any way to estimate the emission factors of raw materials? If so, based on these estimated factors, what percentage each raw material is adding to the overall indirect footprint of the company? What are the top 50% carbon-intensive raw materials? Which suppliers are causing the most emissions? On purchasing point of view, what type of suppliers are they? If not, what assumptions can be made to reduce overall the carbon emissions of the company? Can a new optimized purchasing model be implemented that is more sustainable? What inputs should be taken into consideration in the purchasing model? Are these inputs qualitative or quantitative and how should they be prioritized? Based on the model, which suppliers should be selected in different scenarios (cost, distance, and environmental friendliness)?

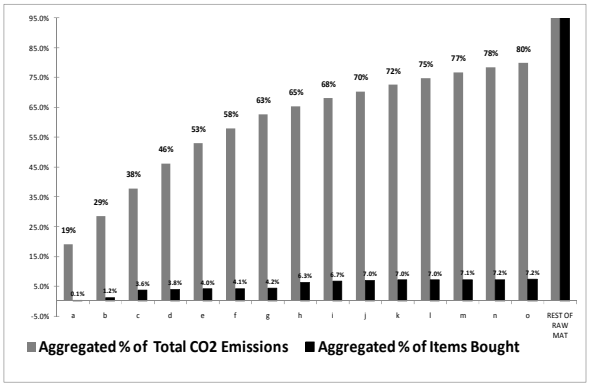
The main goal of the research is to evaluate the indirect emissions of a pharmaceutical company and to provide insights into more sustainable purchasing by building an optimized purchasing model based on the use of a matrix of factors that will be created through a literature review and a company's current supplier classifications. As the trend to be sustainable is inevitable due to climate change, the image of innovation and social responsibility will become increasingly important, and only those who initiate change will become even more profitable in less time compared to those who are just followers. That is what makes a company a leader and pioneer in the industry, always going one-step ahead.

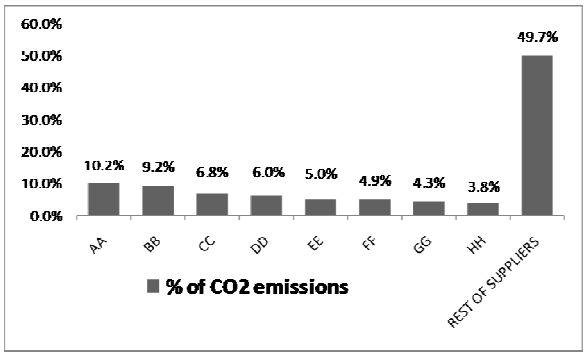
As making estimates of the indirect footprint results are too complicated for companies due to the information needed for the calculations, our proposal is to build a differentiation factor with public information related to sustainability for each supplier of the company. This factor will allow the model to be as simple as possible and straightforward to build. This will allow perfectly defining or prioritizing the characteristics to be used when choosing one supplier among the rest.

The most common criteria used by several authors in approaching green supplier selection and a sustainable purchasing model is environmental image and policy, environmental certification and carbon emission numbers. Thus, these criteria are taken into consideration since they are recurrent. Other researches proposed models using weights, which can lead to prioritizing some combinations in a way the user has not intended. For that reason, a differentiating factor is built. This differentiating factor will be capable of capturing all the information needed to provide a precise prioritization of events or outcomes.

Preliminary Analysis

Based on the estimated emission factors that were provided, it was seen that 80% of the CO_2 emissions are produced by 7% of the items bought, and that 7% account for 75% of the total purchases. With these results, it is evident that helping to reduce the emissions of these suppliers will substantially decrease the overall indirect footprint of the company. Following figures show CO_2 emissions per raw materials and suppliers.





Model Introduction

On the inputs page of the model, the amount of desired raw materials to be purchased must be captured in addition to the extra percentage the company is willing to pay to be greener in case the cheaper supplier is not the more sustainable one. A basic model is used to optimize this selection based on price, the differentiating factor and the distance between the suppliers and the production plants.

Rationale for Inputs

The environmental characteristics that will be used to build the differentiating factors, which in the research is the main or primary consideration to choose a supplier, are CDP (Carbon Disclosure Project), Sustainability Report, Carbon Emission Numbers and Environmental Certification (ISO

14001). The prioritization of importance is also done in the same sequence.

As for secondary considerations, two characteristics that are mutually exclusive exist which mean that one will be considered after using the other.

- Supplier segmentation: Given by the company.
- Distance to the Supplier from the production plant.

Differentiating Factor

The Differentiating Factor, here-after referred to as DF, is a factor or matrix of factors which given certain characteristics (either qualitative or quantitative), assigns one and only one number to each possible combination of events (or states of the art) for a certain set of characteristics given and prioritized according to each user characteristic. This set of characteristics can be segmented into primary, secondary, and so on.

To build this unique cardinal factor (DF), the next assumptions should be fulfilled:

Base number: This base number should be strictly greater than the sum of the higher values of the secondary characteristics, e.g., if a secondary characteristic is composed of 3 different states and 0,1,2 respectively is assigned to each state, then the base number should be greater than 2; such as 2.1 or 3. If there are two secondary characteristics and the second secondary characteristic has a maximum value of 1, then the base number should be greater than 2 + 1, e.g. 3 + ε , where ε is a very small number. The reason for this is to avoid wrong prioritization of any factor or duplicates.

For primary characteristics

The sum of the numbers assigned to all the previous characteristics with less priority on the primary ones should be strictly less than the number assigned to this primary characteristic.

For secondary characteristics

Qualitative ones: The maximum number assigned to any of the secondary characteristics should be less than the base number assigned for the primary characteristics. (Base number can be constructed as the maximum number assigned to qualitative secondary characteristics plus ε. The simplest way to assign a number to these qualitative characteristics is 0,1,2,3…n but it is up to the user to define the number as long as every characteristic has a different one.)

Quantitative ones: The equivalence between the range of these quantitative amounts and the minimum difference between the next set of characteristics, either primary or secondary, should be determined. The aim of this is to avoid the overlap between combinations. (For example, for a particular case where the next set after primary numbers is supplier segmentation, defined as 0,1,2,3, the minimum difference between the assigned values is 1. Then, the range of the distances should be transformed into a (0,1-ε) range. The reason to subtract this very small number is again to avoid the overlapping between combinations.) When a secondary characteristic is not sufficient to achieve the uniqueness, then a range as one of the distances mentioned before should be added.

DF is created in order to simplify the model and to make it easy to be replicated in any kind of industry or company. Given a set of characteristics prioritized, one and only one number will be assigned to each combination of possible outcomes in such a way that the optimization model will only have to find either the largest or the smallest result and arrange them according to the needs of the client.

The following table shows unique DF's for each combination of outcome.

Distance (km to production site)	Supplier Segmentation (SS)	Environmental certification 14001	Carbon Emission Numb	Sustainability Report	CDP	Adapted distance	SS	(1) Environmental certification 14001	(2) Carbon Emission Numb	(3) Sustainability Report	(4) CDP	D F without distances	Diferentiating Factor
0	STR	Y	Y	Y	Y	0	-	0	0	0	0	-	-
0	C	Y	Y	Y	Y	0	1.0	0	0	0	0	1	1.0000
2637	L	Y	Y	Y	Y	0.9452	2.0	0	0	0	0	2	2.9452
1603	ST	Y	Y	Y	Y	0.5746	3.0	0	0	0	0	3	3.5746
0	STR	N	Y	Y	Y	0	-	4.5	0	0	0	4.5	4.5000
349	C	N	Y	Y	Y	0.1251	1.0	4.5	0	0	0	5.5	5.6251
1255	L	N	Y	Y	Y	0.4499	2.0	4.5	0	0	0	6.5	6.9499
884	ST	N	Y	Y	Y	0.3169	3.0	4.5	0	0	0	7.5	7.8169
525	STR	Y	N	Y	Y	0.1882	-	0	9	0	0	9	9.1882
2725	C	Y	N	Y	Y	0.9768	1.0	0	9	0	0	10	10.9768
396	L	Y	N	Y	Y	0.1419	2.0	0	9	0	0	11	11.1419
1521	ST	Y	N	Y	Y	0.5452	3.0	0	9	0	0	12	12.5452
2787	STR	N	N	Y	Y	0.999	-	4.5	9	0	0	13.5	14.4990
1172	C	N	N	Y	Y	0.4201	1.0	4.5	9	0	0	14.5	14.9201
1835	L	N	N	Y	Y	0.6578	2.0	4.5	9	0	0	15.5	16.1578
109	ST	N	N	Y	Y	0.0391	3.0	4.5	9	0	0	16.5	16.5391
522	STR	Y	Y	N	Y	0.1871	-	0	0	18	0	18	18.1871
1470	C	Y	Y	N	Y	0.5269	1.0	0	0	18	0	19	19.5269
689	L	Y	Y	N	Y	0.247	2.0	0	0	18	0	20	20.2470
2707	ST	Y	Y	N	Y	0.9703	3.0	0	0	18	0	21	21.9703
901	STR	N	Y	N	Y	0.323	-	4.5	0	18	0	22.5	22.8230
1584	C	N	Y	N	Y	0.5678	1.0	4.5	0	18	0	23.5	24.0678
1668	L	N	Y	N	Y	0.5979	2.0	4.5	0	18	0	24.5	25.0979
2335	ST	N	Y	N	Y	0.837	3.0	4.5	0	18	0	25.5	26.3370
407	STR	Y	N	N	Y	0.1459	-	0	9	18	0	27	27.1459
289	C	Y	N	N	Y	0.1036	1.0	0	9	18	0	28	28.1036
2455	L	Y	N	N	Y	0.88	2.0	0	9	18	0	29	29.8800
2608	ST	Y	N	N	Y	0.9348	3.0	0	9	18	0	30	30.9348
2294	STR	N	N	N	Y	0.8223	-	4.5	9	18	0	31.5	32.3223
664	C	N	N	N	Y	0.238	1.0	4.5	9	18	0	32.5	32.7380
45	L	N	N	N	Y	0.0161	2.0	4.5	9	18	0	33.5	33.5161
1811	ST	N	N	N	Y	0.6492	3.0	4.5	9	18	0	34.5	35.1492
2480	STR	Y	Y	Y	N	0.889	-	0	0	0	36	36	36.8890

When prioritization is assigned, each characteristic has a total prioritization over the rest of characteristics in order to simplify calculations. However, this could also be thought as several pairs of combinations in which a combination of two or more characteristics could be more important than the main characteristic.

DF is created in order to simplify the model and to make it easy to be replicated in any kind of industry or company. Given a set of characteristics prioritized, one and only one number will be

assigned to each combination of possible outcomes in such a way that the optimization model will only have to find either the largest or the smallest result and arrange them according to the needs of the client.

Assumptions and Limitations

One of the main assumptions in this model is infinite capacity, i.e. each supplier can provide as much raw material as the company needs.

As the information from the company regarding price is limited, the insights that the model can provide can be seen when the real prices are plugged in. The only insights to present are for raw materials a, e and f because for this particular ones the information was available.

Finally, although environmental characteristics for DFs are chosen with help of literature, the prioritization of each characteristic within the factor is highly subjective. The publicly available information is a superficial representation of greenness of a company.

Model Application

The only raw materials of which the prices are real are a, e and f. With this information, the model produced the following results:

Raw Material	Supplier	Price	DF	Distance (km)	Environmental certification	Carbon emission numbers	Sustainability Report	CDP
a	AA	3.03	33.048	1031	Y	Y	Y	N
a	BB	3.06	1.000	10	Y	Y	Y	Y
a	CC	2.95	61.050	1081	N	N	N	N
a	DD	89.44	59.000	5	Y	N	N	N
e	SS	6.82	3.073	1561	Y	Y	Y	Y
e	UU	1.13	3.054	1151	Y	Y	Y	Y
f	VV	56.2	35.055	1185	Y	Y	Y	N
f	TT	22.2	1.053	1129	Y	Y	Y	Y

Conclusion

The preliminary analysis of the research showed the percentage purchased of each raw material yearly. Furthermore, it analyzed the percentage each raw material is adding to the overall-indirect footprint of the company. Thus, top 50% carbon intensive raw materials and suppliers of these raw materials were shown. These suppliers were presented to the company along with recommendations.

As a first approach to any company, the construction of differentiating factors can be of huge help to decrease the overall indirect emissions; nevertheless, this should only be the first step of the journey. Using the bottom-up approach and having rough estimates about the CO_2 emission factors of each raw material, an estimate about the indirect emissions per supplier should be obtained and top contributors should be determined.

In parallel, a model will still serve as guidance for the company using differentiating factors constructed with public data. These factors will range from zero to a certain number according to the number and type of characteristics used. The number of unique DF´s can either be part of a finite set of numbers or an infinite set depending on the final secondary characteristic chosen.

Purchasing model was applied to top 4 carbon intensive raw materials and their suppliers. Three different scenarios, based on price, distance and environmental considerations, were applied and presented. The company can use these scenarios and the model as a basis for purchasing decisions

Recommendations

When no estimations regarding CO_2 emissions is available, then using Pareto´s law regarding the total amount purchased per suppliers can be chosen to start. After this, depending on the relationship the company has with the suppliers as well as the segment they belong (strategic, crucial, standard or leverage), the company should start approaching suppliers. (The consultants that are experts in CO_2 emission factors shall conduct deeper research regarding the questions that should be asked to give the company some insights regarding the CO_2 emissions of the supplier.)

An alternative to improve the process of improving the indirect emissions of the company is to look for a relationship of the CO_2 emissions of the company and their suppliers. This can be achieved by running a regression with differences between the real emissions and the estimations made by the company on the main contributors pointed out as a preliminary result and the DFs obtained before. If a relationship between these two concepts exists, then a generalized rule to calculate indirect emissions can be built based on the actual estimations the company has. These results can also be extended as an approximation regarding Tier 2 suppliers but it is a very extensive research given that in most cases, the amount of Tier n suppliers could be very large.

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